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WOOD REMAINS FROM ANDEAN ARGENTINA: THE USE OF *Prosopis* SP. L. IN HUT CONSTRUCTION

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ABSTRACT.—A desiccated fragmented wooden post, part of the structure of a hut, from the archaeological site of Carrizal de Azampay, Department of Belén, Province of Catamarca, Argentina, was identified and interpreted. The material was broken manually for the analysis. Transverse, radial, and tangential sections were examined with a stereoscopic and incident light microscope and SEM. The remains were identified as either *Prosopis flexuosa* DC or *P. chilensis* (Mol.) L. Stuntz, both of which are common species in the study area. This paper confirms the prehistoric use of this genus in construction and analyzes the function of the post as a part of the hut structure. In addition, recent changes in the utilization of both cultivated and native tree species are discussed.

Key words: Andean region, Argentina, archaeological wood, *Prosopis*.

RESUMEN.—El presente trabajo se basa en la identificación e interpretación de un poste de madera, fragmentado y desecado, perteneciente a la estructura de una vivienda, procedente del sitio arqueológico Carrizal de Azampay localizado en el actual Departamento de Belén, Provincia de Catamarca, Argentina. El material fue fracturado manualmente en laboratorio. Se examinaron las secciones transversal, longitudinal tangencial y longitudinal radial del mismo con Microscopio Estereoscópico, de Luz Incidente y Electrónico de Barrido. Los fragmentos fueron identificados como *Prosopis flexuosa* DC o bien *Prosopis chilensis* (Mol.) L. Stuntz, especies comunes en el área de estudio. El trabajo confirma el uso prehistórico de *Prosopis* como recurso maderero y analiza la función del poste dentro de la estructura de la vivienda. Asimismo se discuten, a partir de observaciones etnográficas, procesos modernos de cambio en el modo de uso de este recurso a partir de la incorporación de especies cultivadas.

RÉSUMÉ.—Ce rapport analyse et interprète un fragment desseché de pieu provenant de la structure d'une hutte et trouvé sur le site archéologique de Carrizal de Azampay, département de Belén, province de Catamarca, Argentine. Les morceaux de bois ont été brisés à la main pour l'analyse. Les sections transversales, radiales, et tangentielles ont été examinées aux trois microscopes suivants: stéréoscopique, à lumière incidente, et éléctronique à balayage. Nous avançons deux hypothèses pour l'identification de l'espèce de bois: il s'agit ou bien du *Prosopis flexuosa* DC. ou bien du *P. chilensis* (Mol.) L. Stuntz. Ces deux espèces d'arbres sont communes dans la région. Cette étude confirme l'utilisation préhistorique de

ce genre pour la construction et analyse la fonction du pieu dans la structure de la hutte. Cet article aborde également les récents changements survenus dans l'utilisation d'espèces d'arbres cultivées et indigènes.

INTRODUCTION

The interpretation of wood remains from archaeological sites is important for understanding past plant uses and plant-human evolutionary processes (see Smart and Hoffman 1988), as well as for understanding mechanisms of prehistoric deforestation (Willcox 1974). In Argentina, studies of archaeological wood are rare; however, they are increasing (see for example Garibotti 1998; Heyne 1992; Rodríguez 2000; Roig and Bárcena 1997).

The main goal of this work is the identification and interpretation of a fragmented desiccated wooden post from the archaeological site of Carrizal de Azampay (27°19′ south latitude and 67°02′ west longitude) and the discussion of the changes resulting from the introduction of some exotic woody species in the area.

Regional Setting.—The site of Carrizal de Azampay is located a few kilometers from the modern village of Azampay, in the Department of Belén, Province of Catamarca, Argentina, at an elevation of 2000 m asl. The region is semiarid and the climate subtropical. The mean annual temperature is 18°C, with a range between about 9° and 25°C. The average annual precipitation is about 300 mm, with rainfall occurring mainly in summer. Phytogeographically, the area belongs to the Monte Province, Chaqueño Domain, Neotropical Region (Morlans 1985). The main plant communities are: 1) shrub steppes of *Larrea cuneifolia* Cav., *Plectrocarpa rougessii* Desc. O' Don. et Lourt., *P. tetracantha* Gillies ex Hook & Arn, *Bulnesia schickendantzii* Hieron. ex Griseb. and *Senna rigida* (Hieron.) H. S. Irwin & Barneby, among others, on alluvial terraces and colluvial piedmonts found up to an approximate elevation of 2200 m asl; 2) isolated stretches of open forests of *Prosopis flexuosa, Prosopis chilensis* and *Bulnesia retama* (G. ex H) Griseb. along riverbanks and wetter areas; and 3) grasslands above 2200 m asl.

Unfortunately, there is no paleoclimatic record available for this area. From data related to periglacial sedimentological features in Patagonia, Mercer (1976) concluded that three glacial advances had occurred during an interval of neoglacial cooling which spanned the last 5000 years. The first one occurred between 4700 and 4200 B.P., the second, between 2700 and 2000 B.P. and the third one, the Little Ice Age, over the last three centuries. It is important to note that such neoglacial fluctuation has been confirmed elsewhere in the Andes and in the northern hemisphere (Schubert and Clapperton, in Rabassa and Clapperton 1990). As Prentice (1992) noted, however, even when pollen profiles from different areas record the same climatic fluctuation, differences in timing of the event could result from geographic variation (such as elevation and slope aspect), the sensitivity of a particular plant community to climate changes, or variations in the intensity and duration of the climate event. Therefore, it is difficult to hypothesize about Monte vegetation fluctuation from these data. However, the authors agree with D'Antoni (1976), who has proposed for the Gruta del Indio, Province of Mendoza, a warm and dry period between the years 5500 and 3000 B.P., based on pollen analysis.

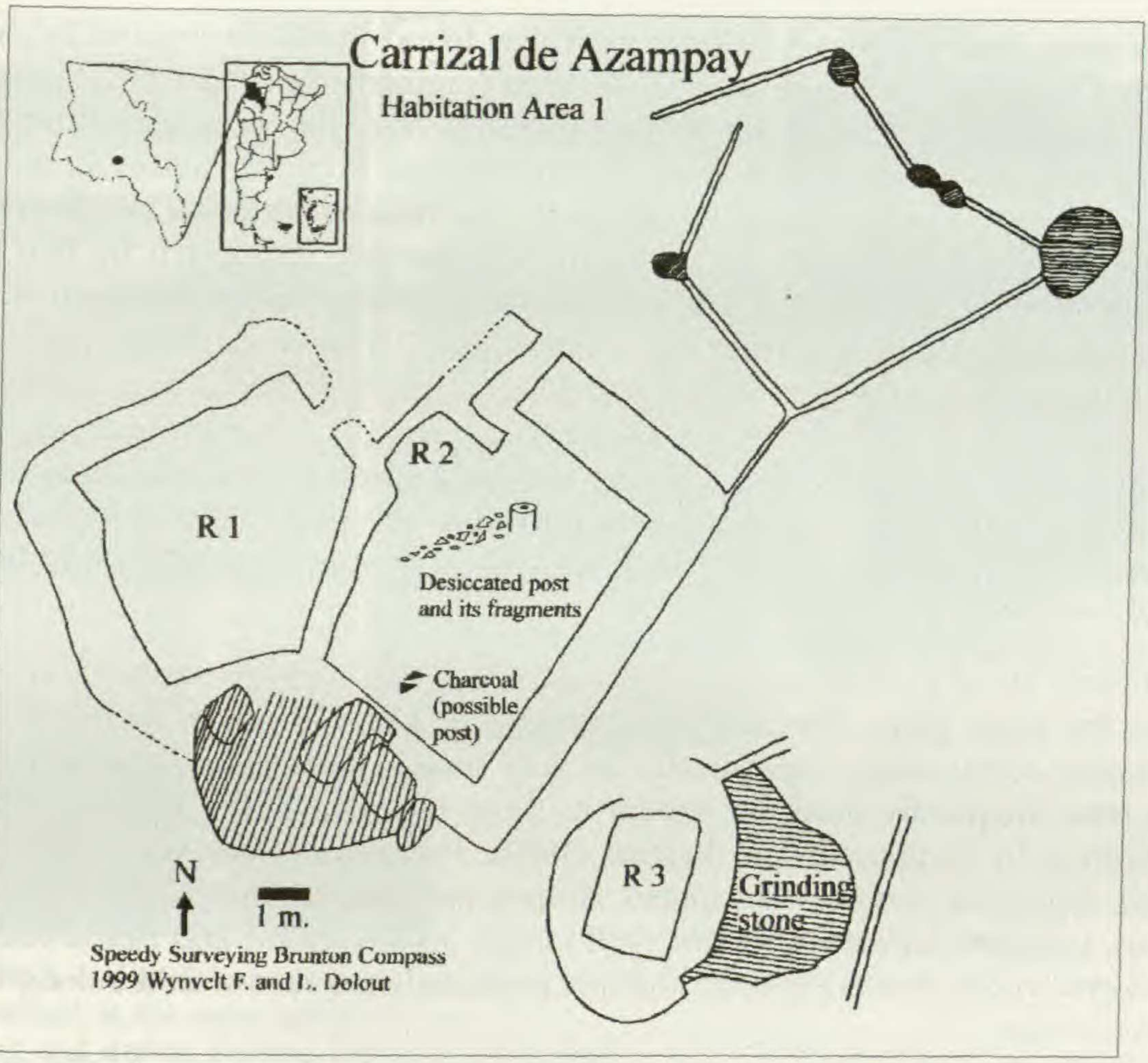


FIGURE 1.—Geographical location and plan of the site at Carrizal de Azampay showing the location of the post remains.

During this period the Monte Phytogeographic Province would have reached its maximum size. Then, between the years 3000 and 2000 B.P., the climate became cold and wet, causing the spatial reduction of the Monte to its present distribution. The climate after 2000 B.P. became similar to that of the present day, and human activities began to have an impact on the landscape.

The Site and the Archaeological Context.—Ongoing archaeological research is being carried out at two closely related sites 3 km apart, Carrizal de Azampay and Loma de los Antiguos. Carrizal de Azampay, in particular, has three habitation areas vertically distributed along the south-facing piedmont of the Quebrada El Carrizal. Ancient artificial cultivation terraces are associated with each of these areas. It is thought that this settlement pattern supported extended families of farmers of the Belén culture during the Regional Developing Period (A.D. 1000–1500) (Balesta and Zagorodny 1999:271; Sempé 1999:250; Zagorodny and Balesta 2000).

Habitation Area 1 has two rectangular rooms (R1 and R2) and a communal stone for grinding (R3) (Figure 1). Radiocarbon dating of charcoal from R1 has yielded a date of 310 ± 60 ^{14}C years B.P.—1σ calibrated date range from A.D. 1487 to 1657. Based on the recovered archaeological remains, however, especially the ceramics, it is thought that A.D. 1487 is the date that best fits this site.

A desiccated preserved wooden post was found in R2 during the fieldwork directed by Dr. M. C. Sempé in 1981. The non-fragmented portion of the post was 35 cm long in all—20 cm above the occupation floor of the room and 15 cm sunk vertically into the occupation floor. The occupation floor was encountered at a depth ranging between 70 and 90 cm under the modern surface. The post was in a standing position directly on the bedrock of the hill, supported by two large granite stones. It was located 4.20 m from the southern wall of the room, 2.85 m from the northern, 2.4 m from the western and 2.0 m from the eastern. Since many fragments of the post were found longitudinally spread along a two-meter line away from its base to the southwest (see Figure 1) at the same depth of the occupation floor, it seems that the post fell down during—or a few years after—occupation, and that it gradually decayed over the past 500 years. This post, estimated to have been at least 2.35 m long, is thought by Zagorodny and Balesta (2000) to have supported the roof.

Traditional Use of Construction Resources.—Although in Azampay and surrounding areas the exotic genus *Populus* sp. L. (*álamo,* poplar) is nowadays commonly used for house construction—specifically for roof trusses and beams—the native species most frequently used are similar to those recorded at the nearby village of El Shincal by Capparelli and Raffino (1997): *Prosopis chilensis* and *P. flexuosa* (*el árbol*), *Zuccagnia punctata* Cav. (*pupo*), *Porlieria microphylla* (Baill.) Desc. O'Don. et. Lourt. (*chucupi*), *Lithraea molleoides* (Vell.) Engl. (*molle córdoba*) and *Acacia visco* Lor. Ap Gris. (*visco*). It was expected that the post analyzed here would belong to one of these taxa.

Today, traditional houses are constructed in one of two ways. Adobe or stone walls may be built first, and the roof is then supported by them. The roof is generally single pitch, constructed in successive layers as follows: 1) beams, which could be made from tree or cactus trunks, 2) twigs or canes, 3) grass, 4) and a beaten surface made from mud and water. The second type of house involves erecting a wooden structure first, built by means of posts and beams (see Figure 2a). This structure supports the roof. Finally, the walls made of adobe, stones or twigs are built (see Figure 2b, c, and d respectively).

MATERIALS AND METHODS

The intact portion of the post and the dispersed fragments were recovered manually and were stored for twenty years at the Archaeological Scientific Department of the Museum of La Plata. It was evident that even before excavation the post had begun to decay, as seen by intrusive roots in vessels and evidence of fungal attack. After being stored for twenty years in the humid city of La Plata, the post had become highly fragmented and labile, crumbling when cut. The weight of the sample was 177 g, of which 120 g correspond to fragments larger than 1 × 1 × 3 cm (one 4.5 cm wide × 3.5 cm thick × 7 cm long; twelve about 3 × 2 × 4 cm; twelve about 1.5 × 1.5 × 4 cm; thirty about 1 × 1 × 3 cm) (see Figure 3a), while the other 57 g correspond to a great number of minute fragments.

Three planes (transverse, radial, and tangential) of the best preserved frag-

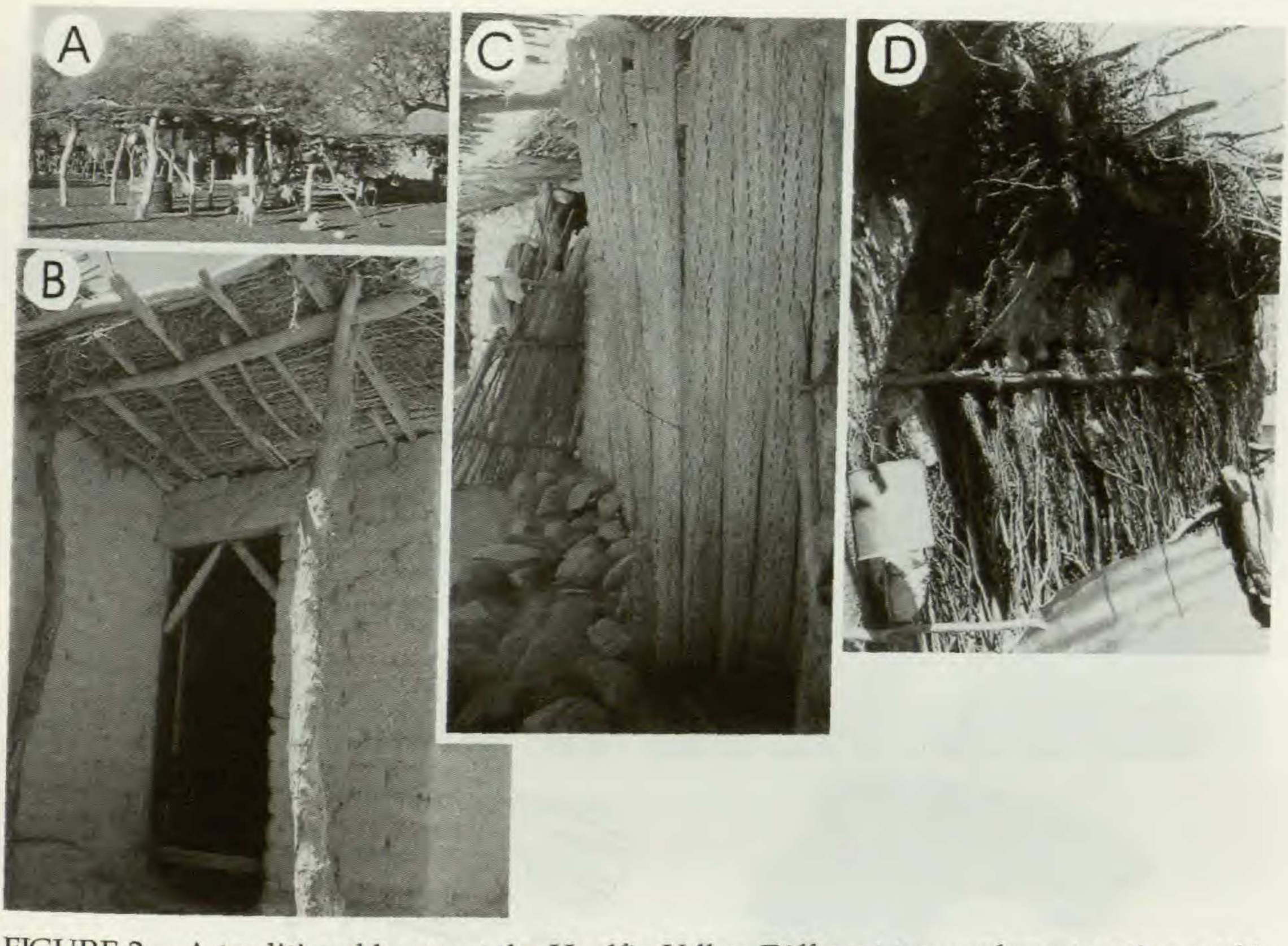
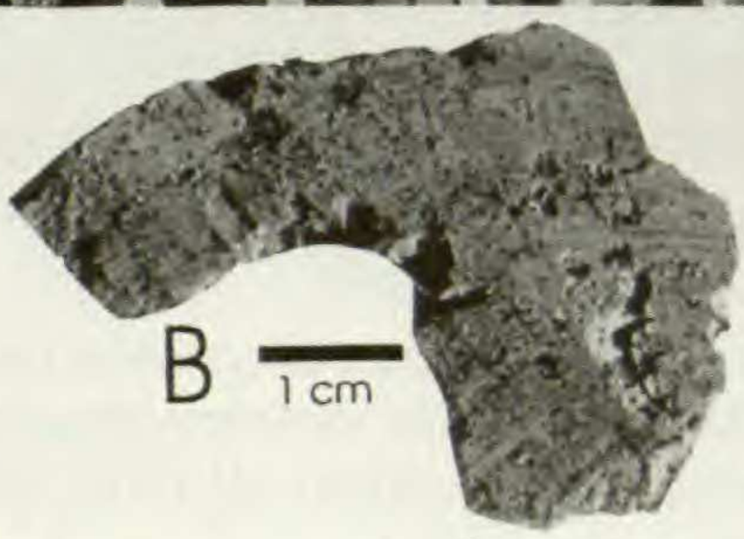


FIGURE 2.—A traditional house at the Hualfin Valley. Different types of construction could be observed at the same habitation area for an extended family: a) wooden structures for shading and drying *Prosopis* fruits; b) adobe bath room; c) stone room; d) twig kitchen.

ments were obtained by manual fracture. The fragments were initially examined under a stereoscopic microscope (Iroscope Mod. M2-14T No. 962329), and for more detail a reflected light microscope (Union ME-3206) was used. One fragment was prepared for SEM examination in a Joel SEM JSM T100. This specimen was mounted on metal stubs with synthetic cement, and then coated with gold. Wood features were photographed at magnifications ranging from 35× to 5000×, according to the amount of structural detail required. Quantitative and qualitative features were described using the "IAWA List of Microscope Features for Hardwood Identification" (IAWA 1989). The quantitative values represent an average of 25 measures, except vessels/mm^2 and rays/mm^2 that represent an average of 5 microscope fields at 4×. In all cases the mean is followed of maximum and minimum values between parentheses.

The number of annual rings of the largest fragment was recorded, and the diameter of the original trunk was estimated from the circumference of its most external ring, following the methodology proposed by Applequist (1958).

Finally, archaeological wood was compared with modern material from the study area in Capparelli's personal comparative collection. Voucher specimens have been deposited for curation in the herbarium of the Scientific Department of Vascular Plants of the Museum of La Plata (LP). Tangential, transverse and radial planes from 1-cm wide slides of air-dried reference material, without previous treatment, were obtained by the use of a microtome.



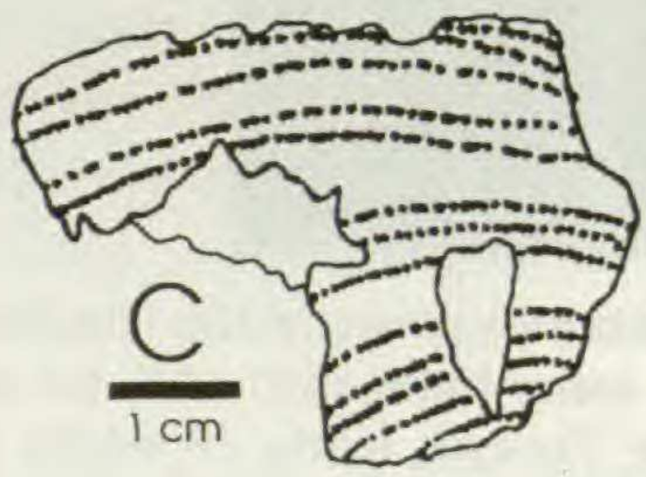


FIGURE 3.—a) General aspect of the best preserved fragments recovered; b) transverse section of the largest fragment where annual rings are evident; c) transverse section diagram showing the 13 annual rings counted.

RESULTS

Identification.—*Prosopis* sp. (Section Algarobia, Serie Chilenses). Due to geographical distribution of tree species of this genus, it is thought that the post could have been made from either *Prosopis flexuosa* DC or *P. chilensis* (Mol.) Stuntz.

Voucher Specimens.—Capparelli 7 (Herbarium of the Scientific Department of Vascular Plants of the Museum of La Plata: LP) and Capparelli 6 (LP) respectively.

Reference Literature.—Wood anatomic descriptions of these species were published by Cozzo (1951) and Castro (1994).

Wood Description.—Due to the fragmentation and poor preservation of the material it was impossible to decide whether or not it had had some processing before use, such as the sharpening of one of the ends for burying or the removal of its bark. The diameter of the original trunk was estimated to have been equal to or larger than 19 cm. The number of annual rings of the largest fragment was 13 (Figure 3b and c). The color of the wood was brown.

Transverse section (Figure 4a). Growth ring boundaries distinct. Wood semi-ring-porous. Vessels mostly solitary (64%) and in radial multiples of two (20%),

commonly more frequent in early wood. Vessels in radial multiples of three or four scarce (4% and 8% respectively) and more frequent in late wood. Tangential diameter of vessel lumina 87 μ (29–194 μ), and density 35 vessels/mm² (32–44 vessels/mm²). Thin- to thick-walled polygonal outline fibers (lumina/double wall thickness index = 2.4 μ). Diameter of fiber lumina 8.2 μ (4.2–12.7 μ). Mean fiber length 248 μ (85.1–364.1 μ). Axial parenchyma abundant, confluent paratracheal and in bands (30 to 54 cells wide). Straight rays with a frequency of 6 rays/mm (5–6 rays/mm).

Tangential section (Figure 4b). Rays 1- to 8-seriate, more common 5-seriate, and ray width 42.3 μ (16.3–88.4 μ). Ray height 24 cells (8–50 cells) and 265.8 μ (119–460.6 μ). Aggregate rays present occasionally. Vessels extending vertically or partially sinuous. Mean vessel element length 140 μ (96.6–185.3 μ). Simple fiber pits. Fusiform parenchyma cells present as well as 2 or 3 cells per parenchyma strand. Prismatic crystals in chambered axial parenchyma cells. One crystal per chamber.

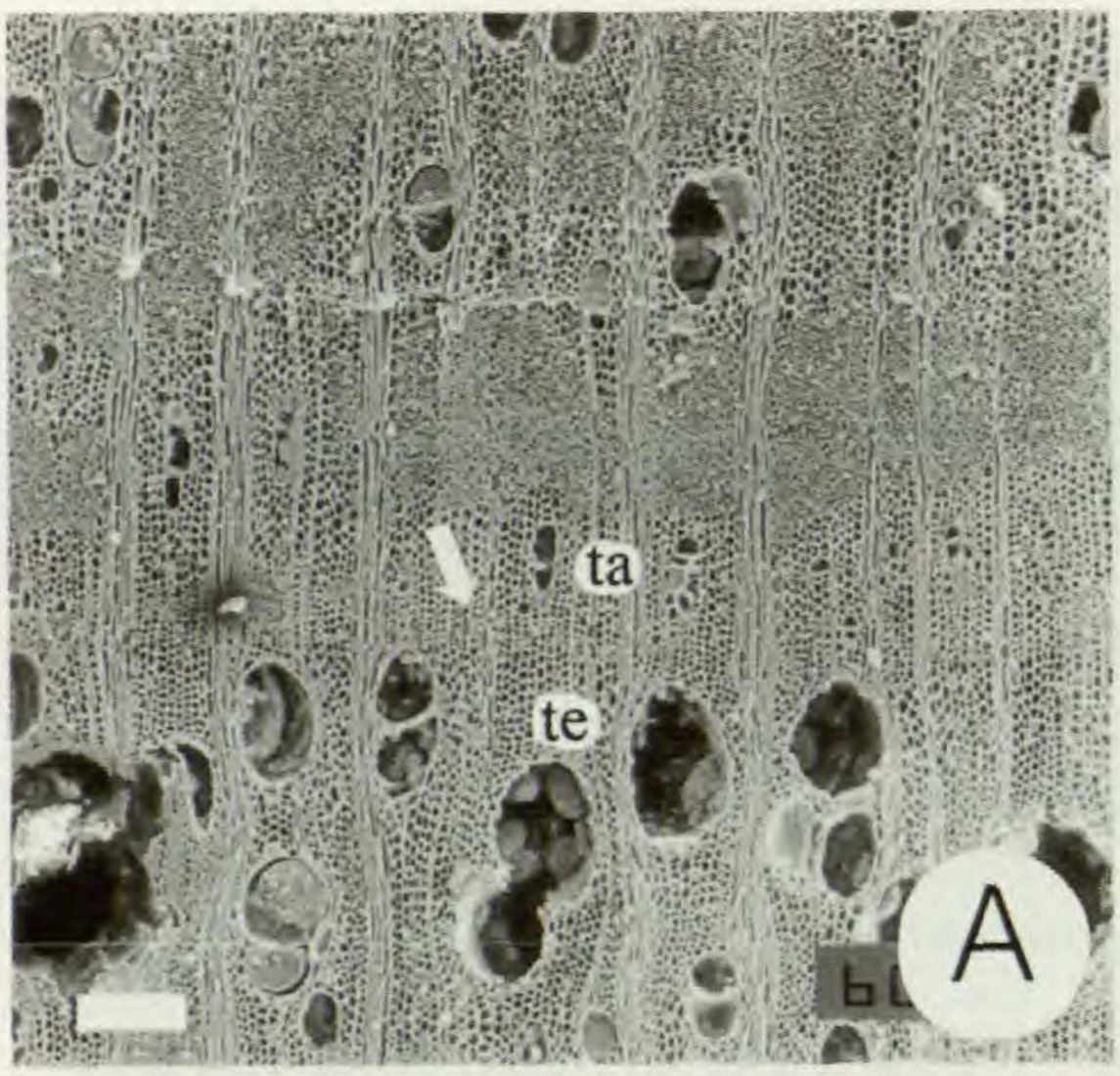
Radial section (Figure 4c). All ray cells procumbent. Simple perforation plates, oblique in narrower vessels and horizontal in larger vessels. Alternate intervessel pits. Size of pits 5 μ (3–6 μ). Vestured pits and vessel wall (Figure 4d).

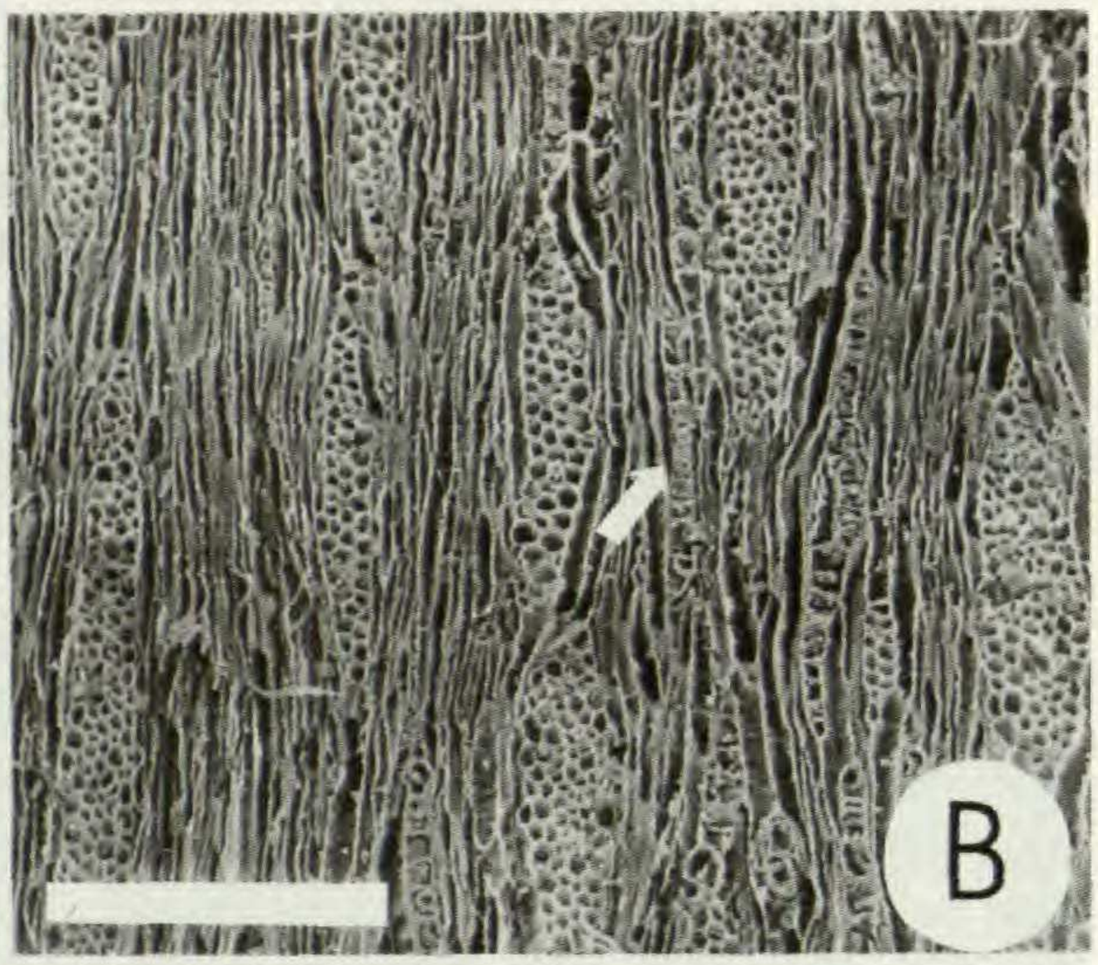
Finally, Figure 5a–d shows transverse, tangential and radial views of *Prosopis flexuosa* and a detail of the vessel inner wall for reference, and Figure 5e–h shows the same sections for *Prosopis chilensis*.

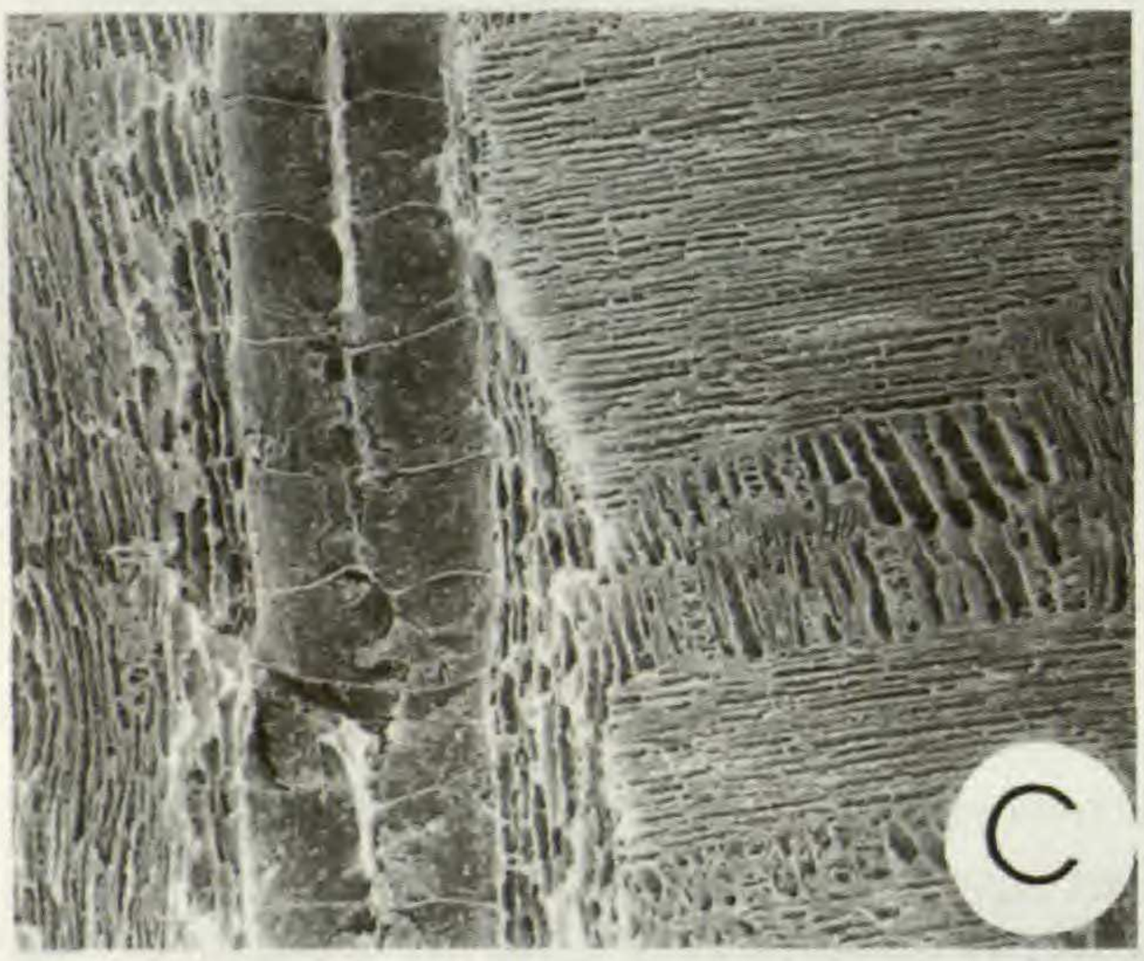
DISCUSSION AND CONCLUSIONS

As described by Pochettino (1985:206), several findings of pods and seeds of *Prosopis* from archaeological sites of northwestern Argentina have demonstrated that this genus has been an important food resource from 4000 B.P. to the present, even in cases where agriculture was the main subsistence activity. However, the literature mentioning the importance of *Prosopis* wood as a construction resource in the past is sparse (see for example the compilation made by Raffino 1990:172–174). The present work not only confirms its past use as a resource for wooden structures, but also allows us to infer the past presence of this genus in the study area. According to the present-day distribution of plant communities, *Prosopis* could have been collected either from the riverbank communities of narrow valleys adjacent to the site or from the open forests surrounding the village of La Ciénaga, 10 km from Carrizal de Azampay.

Modern studies of tree rings, growth rates and age-size relationships of *Prosopis flexuosa* in central-west Argentina (Martijena et al. 1988; Perpiñal et al. 1995; Villagra et al. 2002) allow us to calculate the values of different related variables, such as diameter of the trunk, age, height, and commercial value of an individual tree. The estimated age for an individual of 19 cm diameter would be, for example, 40 years, while its height would be approximately 4.8 m. Unfortunately, micro-regional climatic and ecological features affect growth rates of this genus. Therefore, extrapolation of data from other regions might not be valid. On the other hand, data coming from the nearby village of El Shincal show that in open forests both *Prosopis flexuosa* and *P. chilensis* can reach a height of 5–7 m, while *P. chilensis* of the closed-canopy riverbank forests (less frequent and further away from the







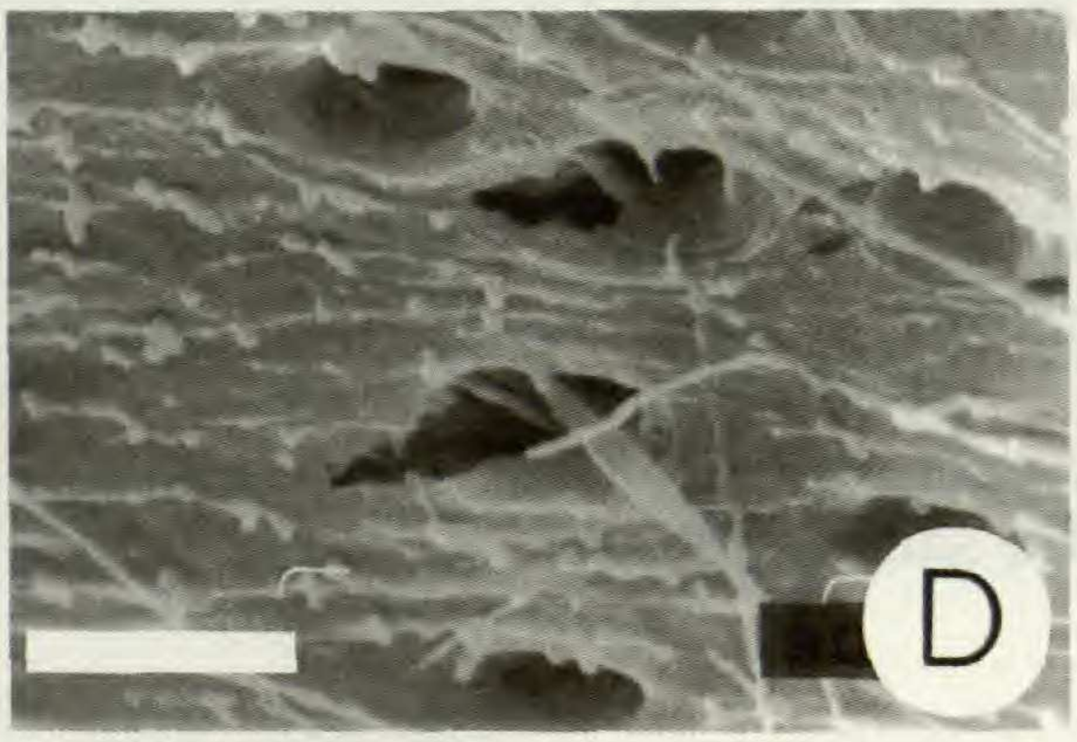


FIGURE 4.—Archaeological *Prosopis* sp. (SEM): a) transverse section (TS) showing the border of an annual ring (arrow), early wood (te) and late wood (ta), semi-ring porosity, axial paratracheal parenchyma confluent to bands, and deposits in vessels; b) tangential longitudinal section (TLS) showing uni- to multiseriate rays and crystals (arrow); c) radial longitudinal section (RLS) showing all cells procumbent in rays; d) detail of the vestured layer of the inner vessel wall and pits. Scale (white bars): a–c, 200 μ; d, 5 μ.

site than the open forest) reaches a height of 9–10 m. The most useful length for posts of this species is 2 to 3 m, because at this height the main trunk usually branches into two or more limbs. Posts are usually cut so that a short length of the branched end remains, to better support the beam. In addition, *Prosopis* is a hard and durable wood (even under water) due to its high tannin content (Castro 1994:13). These advantages are well known to modern local people, and surely were also known to inhabitants in the past.

Judging from the location where it was recovered, the post seems to have been one of the supports of a longitudinal beam. A second post may have been located where some big fragments of charcoal were recorded—but unfortunately not recovered—by Sempé during excavation (see Figure 1). It is not known which species was used for beams. It might have been difficult, however, to find a 7-m

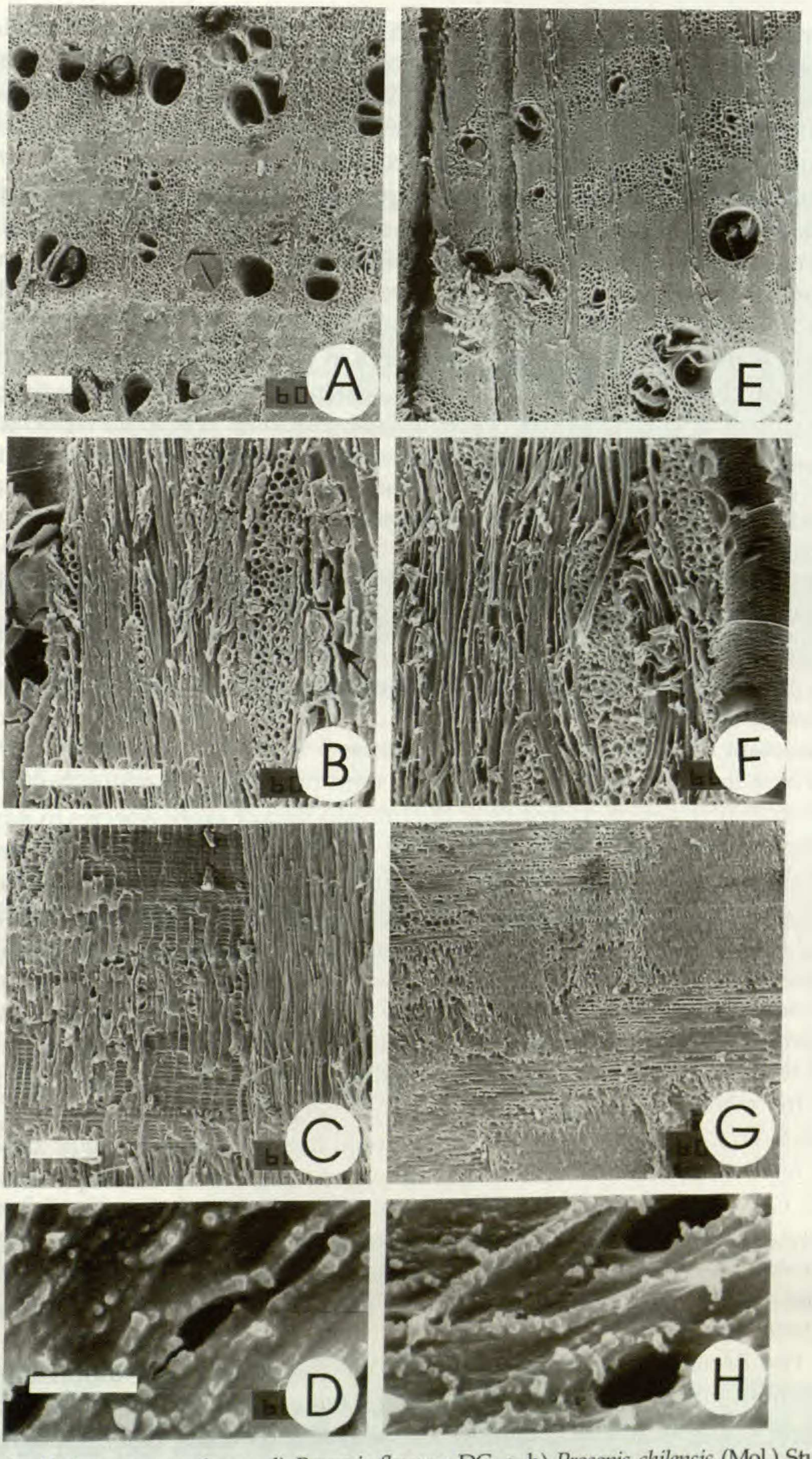


FIGURE 5.—Reference samples: a–d) *Prosopis flexuosa* DC; e–h) *Prosopis chilensis* (Mol.) Stuntz. a) TS; b) TLS showing crystals (arrow); c) RLS; d) detail of the vestured layer of the vessel wall; e) TS; f) TLS; g) RLS; h) detail of the vestured layer of the vessel wall. Scale (white bars): a–c and e–g, 200 μ; d and h, 5 μ.

long trunk for spanning the entire length of the room, but two posts could have supported two 3.5-m long trunks that would have served as a central beam. The shallow hole in which the post was set (15 cm beneath the occupation floor) and the stone circle at the base of the post that helped to keep it in place indicate that the post was held in place by downward vertical pressure; otherwise it would have fallen down. It is not clear what happened to the roof of this room after its abandonment. It might have been blown off by the strong winds characteristic of the area—mainly the Zonda, a wind originating in the Pacific Ocean that discharges all its humidity on the west side of the Andes. (When the Zonda goes down the east side of the Andes and comes to northwest Argentina, it becomes dry and warm, and blows along the valleys in north-south direction at any time of the year, but especially in spring. The maximum mean velocity registered for the Zonda is 28 km/h [Servicio Meteorológico Nacional 1969, data collected 1951–1960]). The post appears to have been fractured at the floor level. There is no evidence it was intentionally broken, so it is thought that insect or rodent attack (for example, by *Ctenomys* sp.), in combination with water erosion on the ancient surface, could have caused the fracture.

Another question that arises from this work is why people of this site used *Prosopis* for posts and not other species, such as *Bulnesia retama, Lithraea molleoides* or *Acacia visco.* Possible answers are that while both *B. retama* and *Lithraea* are as hard as *Prosopis,* the former is a very short tree and the latter is likely to have grown much far away from this site. *A. visco* is softer than the others and less rot-resistant than *Prosopis* in moist conditions.

There have been changes in the long-term pattern of the management of construction resources associated with the introduction of exotic species in Argentina during the period A.D. 1800–1900. Many of them seem to be substitutions rather than changes in construction methods. For example, the exotic *álamo* (*Populus* sp.) replaced native trees for roof beams. *Populus* has much softer and less durable wood than *Prosopis,* and today is generally employed for making matches or packing boxes (FAO 1980). In Argentina it is the second most important cultivated tree, between *Pinus* sp. and *Eucalyptus* sp. (Politzer 1987). Despite the fact that in Catamarca *Populus* is widely used as a field and border tree along irrigation canals, its planting for processing in sawmills is minimal (IFONA 1985). It is thought that the modern uses of *Populus* could have been expanded because it is easy to grow from grafting twigs and can be planted in small plots. Technological factors also favor its cultivation; it is straight, long and easy to work compared with the hard *Prosopis.* In Europe, throughout prehistory, *Populus* satisfied wood needs of farmers in regions with scarce wood resources (FAO 1980). Similar cases of substitution have been observed by Johanessen and Hastorf (1990) in the Mantaro Valley. In this case cultivated *Eucalyptus* sp. replaced cultivated indigenous trees for fuel.

The decrease in *Prosopis* use could be also related to a diminution in the availability of this type of wood. Although there seems to be a decline in the use of native forests for raw material for sawmills (Politzer 1987), modern use of *Prosopis* for wood fuel, charcoal, and posts is well documented for Catamarca (IFONA 1985). The use of *Prosopis* could reduce the native forests, a problem

which could also be intensified by the fragility of arid ecosystems—according to Martijena et al. (1988), *P. flexuosa* forest in Córdoba take 40 years to regenerate.

Further charcoal analysis on material from R1 of Carrizal de Azampay and from R21 of La Loma de Azampay will allow a better understanding of the use not only of wood construction resources, but also of wood resources in general and their prehistoric pattern changes.

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